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METHOD AND DEVICE FOR MINIMIZING UNWANTED TRANSFER OF TONER IN A TRANSFER PRINTING STATION OF AN ELECTROGRAPHIC PRINTING MACHINE

The invention concerns a method as well as a device for printing of information by means of an electrographic printing device. Such printing devices are known in a plurality of configurations, for example as electrophotographic printing devices, as ionographic printing des or as magnetographic printing devices, whereby various physical effects are respectively used in order to initially generated a virtual image on an intermediate image carrier, ink this virtual image with suitable dye (in particular toner) and transfer-print the image so generated onto a recording medium.

Such digital printing methods for variable data are, for example, specified in the publication "Das Druckerbuch, Technik und Technologien der Océ-Drucksystem, Drucktechnologien, Océ Printing Systems GmbH", 6th edition (May 2001), ISBN 3-000-00 1019-X in chapter 9, third section (pages 9-21 through 9-36).

For printing of sheet-form recording medium, it is known from US 6,044,244 A to respectively pass the recording medium on a transport band to the intermediate image carrier. The transport band thereby effects that the sheet-form recording medium remains on its desired transport web because it adheres to the transport band and does not remain electrostatically adhered to the intermediate image carrier, whereby a paper jam can be prevented.

It has emerged that, in transfer printing arrangements that comprise such a transport band for sheet-form recording medium, toner particles are transferred from the intermediate image carrier onto the transport band. The cause for such an unwanted toner transfer onto the transport band can, for example, be a print image projection in which the transferred image is larger than the format of the recording medium. Toner markings in the edge region of the intermediate image carrier or in

the intervening spaces that result in the spaces between successive recording media (what are known as gaps) can also lead to such unwanted toner transfers onto the transport band. A regulation method for developer stations that operate on the basis of toner markings is known from the publication WO 99/36834 A1.

Further causes for an unwanted transfer of toner onto a transport band are undefined charged toner particles (background) that are located on the inked image of the intermediate image carrier as well as toner image regions that are not transfer-printed dependent on the transfer printing efficiency $\Pi_{Transfer}$.

An electrographic printing device with a plurality of transfer printing stations and a transport band for transportation of the recording medium is known from JP 2002-169385 A. Electrographic printing devices with a reservoir for residual toner are known from JP 2000-181312 A and from JP 11265090 A.

A method for operation of a transfer printing station of an electrographic printing device is known from EP 0 339 673 A2, in which the transfer printing potential in the region of the transfer printing station is dissipated as long as no paper traverses the station.

It is the object of the invention to specify a method and a device for an electrographic printing device with which unwanted toner transfer is prevented in a transfer printing station in which the sheet-form recording media that are passed by a light-sensitive medium by means of a transport band for the purpose of transferring toner images.

This object is achieved via the invention specified in the independent claims. Advantageous embodiments of the invention are the subject matter of the sub-claims.

An inventive transfer printing station comprises a light-sensitive medium onto which a toner image adheres by means of electrostatic forces that are effected by an electrical potential as well as a transport band on which the recording medium is held by means of electrostatic forces for the purposes of the transfer printing of the toner image from the light-sensitive medium onto a sheet-form recording medium. The transfer printing thereby ensues by means of electrostatic forces that is [sic] effected by an electrical transfer printing potential opposite the potential of the toner image. The electrical transfer printing potential is dissipated while the light-sensitive medium passes an intervening space lying between two recording media. Via the temporary dissipation of the transfer printing potential, it is possible in the intervening space to generate a toner marking on the light-sensitive medium, whereby this is transfer-printed onto the transport band to an only insignificant degree. Such toner markings are useful in order to regularly adjust electrographic parameters, however should optimally also not be transfer-printed onto the recording medium. With the invention, a solution is specified in order to, on the one hand, be able to use toner markings with high performance, i.e. without reducing the printing speed, and on the other hand to prevent an interfering transfer printing of the same toner markings.

With the invention, it can furthermore be prevented that unwanted toner particles are transferred from the light-sensitive medium onto the transport band at times of the operation of the transfer printing station at which no recording medium lies against the light-sensitive medium. This effect can be used particularly effectively in the running operation of the printing device, when successive recording media run into the transfer printing station with a certain separation interval or, respectively, intervening space. Via the deactivation of the transfer printing corotron during the times in which the light-sensitive medium passes the intervening space (gap), and thus the transport band contacts the light-sensitive along a wide surface, no or only a few toner particles are transferred from the light-sensitive medium onto the transport band. In particular it is prevented that, in

addition to the mechanically-dependent transfer, toner arrives onto the toner band due to the electrical transfer printing potential.

In an advantageous embodiment of the invention, a control device is used that, from the image sequence of the electrographic recording process, derives at which times no recording medium lies against the light-sensitive medium and then effects the dissipation of the transfer printing potential. The transport band has in particular an electrical volume resistance greater than $10^{10}\ \Omega$ cm, whereby the transfer printing potential also effects the electrostatic forces to hold the recording medium. Both the light-sensitive medium and the transport band can be provided with cleaning stations that effect a continuous cleaning of toner particles still located on the respective element. The cleaning stations can furthermore comprise mechanically persistent contacting ends via which the toner particles can be abraded. To clean the scratch-sensitive photosensitive medium, a softer material such as, for example, rubber or soft plastic is thereby preferably provided, while harder material such as, for example, metal, hard plastic or ceramic and in particular polyimide can be used for cleaning of the more robust transport band. The residual toner reservoirs at both cleaning stations are thereby in particular designed such that they become approximately full simultaneously given average accumulation of residual toner quantities in both cleaning stations. In this case, it is sufficient to arrange at only one of the two reservoirs a fill level sensor with which it is shown to the operator of the device when the residual toner reservoirs are to be emptied or, respectively, exchanged with empty reservoirs.

With the invention, an arrangement is thus specified with which the accumulation of residual toner in an electrographic device can be specifically conducted into specific processing channels, whereby in particular a compact design can be realized in that arrangements for removal of residual toner are provided that transport the old toner to suitable locations in which sufficient structural space is available for residual toner reservoirs and/or the reservoirs are easily accessible from the outside. The invention in particular enables less residual toner to have to

be processed in crowded structural space of a recording medium transport band and comparably more residual toner to be processed in comparably larger structural space, such as the cleaning station of a photoconductor drum.

Further advantages and effects of the invention are made clear using subsequent exemplary embodiments that are explained using Figures.

Thereby shown are:

Figure 1: an electrophotographic device

Figure 2: transfer printing developer and fixing station in the device of Figure 1

Figure 3: cleaning stations in the region of the transfer printing station.

Figure 4 a transfer printing station in operational state with recording medium on the light-sensitive medium and

Figure 5: the transfer printing station in operational state without recording medium on the light-sensitive medium.

An electrophotographic printing device 21 is shown in Figure 1 in which individual sheet-form recording media made from paper from a paper input can be printed in a first printing group 24 and/or in a second printing group 25 and then be transported to a paper output 26 for depositing in output bays and/or for further processing in further paper processing devices. Each of the two printing groups 24, 25 thereby comprises a transfer printing station 3a or, respectively, 3b in which toner images that are applied onto a photoconductor drum are transfer-printed onto the paper sheet. In order to simultaneously hold in reserve an optimally large spectrum of various papers, the printing device 21 comprises a second paper input

23 that largely corresponds to the paper input 22 with regard to its mechanical and electrical design and can deliver paper pages through the paper input 22 to one or, respectively, both of the printing groups 24, 25 for printing.

A transfer printing station 3 with somewhat more detail is shown in Figure 2. A paper sheet 1 is thereby supplied to a paper transport band 4 via transport rollers 2. The paper transport band 4 is charged to a high electrical potential of 2...5 KV by means of a transfer charging station 8, whereby the paper sheet 1 electrostatically adheres to the paper transport band 4. The paper transport band 4 transports the paper sheet 1 in direction A, whereby the paper sheet 1 wraps around the photoconductor drum 5 within an angle segment alpha, what is known as the nip angle. This in turn moves in direction B with the same speed as the paper sheet 1 or, respectively, the transport band 4. Via the transfer charging station 8, the underside of the paper transport band 4 is charged with an electrical charge with a polarity opposite to the charged toner image on the photoconductor drum 5. The paper transport band 4, designed high-ohmic (10^{10} Ω cm), stores the charge energy similar to a capacitor and represents a high counter-potential relative to the charged photoconductor drum 5. On the one hand, this effects the toner transfer from the photoconductor drum 5 onto the paper sheet and, on the other hand, this effects an adhesion force, decreasing over time t, of the paper sheet 1 to the paper transport band 4. Even after leaving the nip region, the paper sheet 1 still adheres to the paper transport band 4. At the driving roller 4a which the paper transport band 4 wraps around, the paper sheet 1 is loosened from the paper transport band 4 (due to the relatively small radius (11 mm) of the roller 4a and the effect of the stripping plate 4c) and supplied to the fixing device 10, in which the toner image on the paper sheet 1 is fixed via heat and pressure exposure.

The paper transport band 4 is always held under tension by the tension roller 4b and is pressed under tension onto the photoconductor drum 5 in the nip region.

An electrostatically held toner image is generated on the photoconductor drum 5 as follows: the photoconductor drum 5 is initially charged to a high voltage with a charging station 6. Information is then applied point-by-point in an exposure station 7, for example via an LED comb or a laser, and therewith discharge zones are achieved point-by-point on the photoconductor drum 5. Toner that is reserved in a developer station 29 and is prepared for attachment to the photoconductor drum 5 then attaches to these charge zones.

In the course of the transfer printing event, it is practically impossible to prevent that residual toner remains adhered to the photoconductor drum 5. The amount of the residual toner on the photoconductor drum is dependent on what is called the transfer printing degree of efficiency $\Pi_{Transfer}$, with $\Pi_{Transfer}<1$. The total residual toner on the photoconductor drum 5 thus results on the following basis:

Residual toner on photoconductor = 1 - $\Pi_{Transfer}$ (image information + toner marking + background).

Only in the cases in which image information exists outside of the recording medium format or in which toner markings have been generated on the photoconductor drum in the gaps between successive recording media is toner transferred onto the paper transport band. The residual toner on the paper transport band results according to:

$\Pi_{Transfer}$ (image information and background outside of the recording medium format + toner marking).

In Figure 3 it is shown how residual toner is removed form the photoconductor drum 5. For this, the photoconductor cleaning station 9 comprises a corona 9a to be operated with alternating current (AC), via which corona 9a the positively-charged residual toner that is still located on the photoconductor drum 5 after the transfer printing event is electrically neutralized. The electrostatic bonding forces

between toner and photoconductor layer are therewith minimized. The charged toner is stripped from the photoconductor drum 5 with the aid of a rubber lip 11 (arranged dragging), caught in a capture reservoir 12 and subsequently transported with a conveying device 13 into a residual toner reservoir 14 outside of the transfer printing aggregate and easily accessible from the outside. The fill level of the residual toner reservoir 14 is monitored by means of a fill level sensor. At a certain fill level of the reservoir, the operator is prompted via a printer control panel transfer print change the reservoir. If this is not implemented within a specific time, the printing process automatically stops in order to prevent an overfilling of the reservoir.

Possible residual toner that is transferred from the photoconductor drum 5 onto the paper transport band 4 is cleaned off with the aid of a scraping, flexible metal or plastic blade 16 arranged on the paper transport band 4 or a rigid ceramic blade. The blade 16 is thereby arranged directly above a second residual toner reservoir 17, such that the scraped-off toner particles fall directly into the residual toner reservoir 17. If the residual toner reservoir 17 is full, it must also be emptied or exchanged with an empty reservoir. If the fill level of the residual toner reservoir 17 is not monitored, the exchange of the reservoir should occur synchronously with that of the residual toner reservoir 14 of the photoconductor cleaning station 9. In order to prevent an overfilling of the residual toner reservoir 17, the volume of this reservoir must be selected so large that its maximum filling quantity does not exceed the maximum filling quantity of the monitored residual toner reservoir 14 in the photoconductor cleaning station 9. This requires a relatively large volume which requires a significant structural space in the region of the paper transport band and can barely be realized given a compact design of the printing system. It could also be provided to change the second residual toner reservoir 17 dependent on page counters. However, this can lead to the reservoir having to be changed relatively often, which on the one hand increases the consumption costs and on the other hand requires formed [sic] intervention of the operator, and thus leads to

more frequent print interruption, which is not acceptable in a print production environment.

In order to achieve an economical change cycle of the residual toner reservoir of the band cleaning 17 [sic] given low fill volumes and therewith less space requirement, the residual toner amount on the paper transport band is reduced in that the current for the transfer charge is deactivated in the charging station 8 in the intervening spaces of the individual pages to be printed (gap). Figures 4 and 5 show how it can be accomplished. For this, the control device 18 comprises an interface 29 via which it determines (from an imaging unit, for example from the exposure unit 7 or an upstream image processing unit) from which [sic] the page sequence is derived and which carries current supply 19 with which the transfer charging station is supplied. The current supply is thereby deactivated over the length a within the interval of successive pages 1a, 1b (Figure 5); during the printing it is activated (Figure 4).

The distribuion [sic] of the accumulated residual toner quantity is thus dependent on the status of the transfer current: within the format length (in the running direction) of the paper sheets, with activated transfer current the transfer printing degree of efficiency $\Pi_{Transfer}$ determines the ratio of the residual toner quantity on the photoconductor to the band. In contrast to this, between successive paper sheets, meaning when the gap passes the photoconductor drum 5, given deactivated transfer current the toner transfer only occurs due to the areal pressing between the paper transport band 4 and the photoconductor drum 5, meaning only dependent on a mechanical transfer printing degree of efficiency Π_{mech}, which with $\Pi_{mech}<0.5$ is significantly less than $\Pi_{Transfer}$.

Both states are added up as follows:

Residual toner on photoconductor = 1 – $\Pi_{Transfer}$ (image information and background within the maximum image development of the format line,) + 1 - Π_{mech} (image information and background in the gap + toner marking).

Residual toner on paper transport band = $\Pi_{Transfer}$ (image information and background outside of the format width) + Π_{mech} (image information and background in the gap + toner marking).

By means of the transfer current deactivation in the basic acquisition position, the accumulated residual toner quantity on the paper transport band 4 can thus be significantly reduced. In the specified printing systems, the maximum volumes of the residual toner reservoir of the band cleaning 17 are compensated to that of the photoconductor cleaning in the ratio of 1:1, since the maximum residual toner volume on the band does not exceed the volume of the residual toner on the photoconductor. Thus the information of how [sic] the fill level sensor 15 of the residual toner reservoir of the photoconductor cleaning 14 supplies can also be used for the exchange of the residual toner reservoir of the band cleaning 17. The operator then obtains the prompt to exchange and acknowledge both reservoirs at the same time.

Exemplary embodiments of the invention have been described. It is thereby clear that the average man skilled in the art can specify modifications at any time in the framework of his specialist ability. For example, instead of a photoconductor drum a band-shaped light-sensitive medium that is coated with an organic photoconductor or an inorganic photoconductor can be specified.

Reference list

1	paper sheet
1a	precursor paper sheet
1b	subsequent paper sheet
2	transport rollers
3	transfer printing station
3a	transfer printing station of the first printing group
3b	transfer printing station of the second printing group
4	paper transport band
4a	roller of the band driver
4b	tension roller
4c	stripping plate
5	photoconductor drum
6	charging station
7	exposure station
8	transfer charging station
9	photoconductor cleaning station
9a	AC corona
10	fixing station
11	rubber lip
12	catch reservoir
13	conveying device
14	first residual toner reservoir
15	fill level sensor
16	metal or ceramic blade
17	second residual toner reservoir
18	control device
19	current supply
20	band cleaning station
21	printing system

22	paper input
23	second paper input
24	first printing group
25	second printing group
26	paper output
29	interface
30	developer station
A =	paper transport direction
B =	photoconductor transport direction
a =	gap
α =	nip angle